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Concept Paper

Energy Efficiency Standards & Labeling for Appliances

Bangladesh

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CONCEPT PAPER
ENERGY EFFICIENCY STANDARDS AND LABELING FOR APPLIANCES IN BANGLADESH

For

United States Agency for International Development

Under

South Asia Regional Initiative for Energy

Prepared by

NEXANT SARI/Energy

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ENERGY SCENARIO: A SOCIO-ECONOMIC OUTLOOK

To alleviate poverty and achieve sustainable economic development in a country with a population of 130 million and limited indigenous resources is really challenging. It is estimated that Bangladesh requires an economic growth of 6-7% per annum to provide employment to its rapidly growing labor force that cannot be absorbed by the predominant agricultural sector. To achieve such a level of sustainable economic growth adequate and reliable electricity supply is essential. However, during the past decade, Bangladesh has faced a chronic shortage of electricity and consequent regular load shedding not only hinders development but also cause many economic and social problems.

To overcome the power supply problem, Bangladesh needs a significant investment, estimated to be around US$6.5 billion by 2005, for new capacity and upgrading of the distribution system. Such investment will be a significant burden to the country; hence the Government of Bangladesh has initiated power sector reforms and is seeking more private sector participation in power sector development as Independent Power Producers (IPPs).

SCOPE OF THE CONCEPT PAPER

This concept paper aims to highlight the policy makers the importance of Energy Efficiency Standards and Labeling (EES&L) as a tool for sustainable economic development, and broad experiences of similar programs in Asia and Worldwide. The experience of EES&L programs in many countries demonstrates the potential for substantial electricity peak demand reduction and energy savings with attractive cost and benefit ratios. This concept paper also reveals key appliances for EES&L programs in Bangladesh including potential electricity peak demand reduction and energy saving.

APPROACH INVOLVED IN THE CONCEPT PAPER

Demand-Side Management (DSM) studies conducted in several Asian countries have shown that the cost of saving a unit of energy through energy efficiency strategies is much less expensive than producing a unit of energy through a new power plant. The current study has shown that there is a tremendous potential in Bangladesh for energy savings at low cost by the implementation of one of the most effective DSM options, an Energy Efficiency Standards and Labeling (EES&L) program for domestic appliances.

Energy standards are a set of procedures and numbers that define the energy performance of manufactured products, sometimes prohibiting the sale of products where energy consumption is higher than the minimum standard. Energy labels, on the other hand, are the informative labels affixed to manufactured products in order to provide consumers with the data necessary for making informed purchases. An EES&L program offers numerous potential benefits to Bangladesh. These include reduction in electricity peak demand; increased energy security for sustainable economic development; and increased consumer awareness of energy and the environment.

In the absence of recent statistical data on appliances and electricity load profiles, the analysis in this concept paper was based on data gathering from literature researches, questionnaires and expert interviews.The efficiency improvements of domestic appliances based on overseas experience were also used in the analysis.

MAJOR FINDINGS

The electricity supply in Bangladesh has not been able to cope with the rising electricity demand. The industrial and residential sectors are the two largest consuming sectors in Bangladesh. Each sector accounts for nearly 40% of the country's electricity consumption. However, the residential sector plays more significant role in the variation of daily electricity demand that sharply increase in the evening due to the use of domestic appliances. The primary home appliances such as lamps, fans and television typically add 500 to 600 MW to the evening electricity demand. It has been estimated that the annual demand of electric lamps are around 80 million units, of which 90% are incandescent lamps and only 10% are fluorescent lamps.

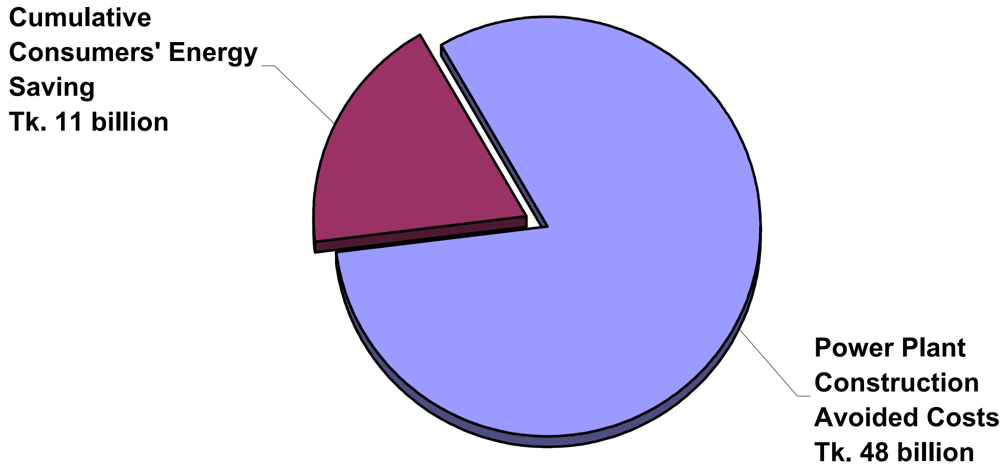
With an introduction of an energy S&L program covering fluorescent lighting, rice cookers and refrigerators complemented by a public awareness campaign to promote efficient appliances, Bangladesh could potentially save 500MW to 700MW electricity peak demand over a five-year period.Considering the high transmission and distribution losses, this corresponds to a generation capacity saving between 625 MW to 875 MW or more than Tk. 48 billion capital investment in new capacity. The corresponding reduction in energy consumption is estimated at 2,800 GWh or Tk. 11 billion over the five-year period.

5-Year Standards and Labeling Program Saving Potential	
Peak Demand Reduction:	500 - 700 MW
Generating Capacity Saving	
(Peak Demand Reduction + 25% system loss):	625 – 875 MW
Cost of 600 MW Power Plant	
(800 MW x Tk. 55 million/MW[1]):	**Tk. 48 billion**
Cumulative Energy Saving:	2,800 GWh
5-Year Consumers' Energy Saving	
(2,800 GWh x Tk. 4.00/kWh[2]):	**Tk. 11 billion**
Total Standards and Labeling Financial Gain	**Tk. 59 billion**

[1] Based on the construction costs of 110 MW Khulna Steam power plant and 360 MW AES Haripur power plant

[2] DESA's annual report

5-Year Standards and Labeling Program Potential



Total Potential Financial Gain: Tk. 59 billion

CHALLENGES AHEAD

To achieve the successful EES&L programs, it is necessary for Government of Bangladesh to focus on proper planning as well as initiating collaboration among relevant stakeholders. However, the absence of information on appliance saturation and end-use consumption in different segments of the residential sector is one of the key challenges that need to be addressed in the short term. The other challenges in pursuing the EES&L concept include:

- Short-term and Long-term funding to support EES&L programs
- A legal framework to facilitate implementation of EES&L programs
- Availability of local energy performance testing facilities

KEY RECOMMENDATIONS

To establish a sustainable S&L program, the following steps are recommended:

1. Establish a Steering Committee with the responsibility of setting energy efficiency standards and labeling for appliances. Such a committee should ideally comprise of representatives from the following major stakeholders:
    - Bangladesh Standards and Testing Institution (BSTI)
    - National Board of Revenue (NBR), Ministry of Finance
    - Ministry of Industries
    - Ministry of Science and Technology
    - Ministry of Power, Energy and Mineral Resources (MPEMR)
    - Bangladesh Power Development Board (BPBD)
    - Rural Electrification Board (REB)
    - Dhaka Electric Supply Authority (DESA)
    - Energy audit cell, electrical advisory/chief electrical inspector
    - Bangladesh Center for Advanced Studies
    - Bangladesh National Scientific and Technical Documentation Center

- The Center for Energy Studies, Bangladesh University of Energy and Technology (BUET)
- Dhaka Chamber of Commerce

2. The Steering Committee prepares a Plan of Action for S&L over a specified period.
3. Conduct a detailed feasibility study to include – market surveys on customer awareness and preferences, appliance saturation and usage profiles, scope of appliance efficiency gains, detailed cost and benefit analysis, institutional framework for S&L, and power system characteristics that are likely to impact on S&L.
4. Establish a mechanism to harmonize standard setting and labeling programs with ongoing programs in neighboring countries.

1.1 SARI/ENERGY

The South Asia Regional Initiative for Energy (SARI/Energy) promotes mutually beneficial energy linkages among the nations of South Asia. SARI/Energy is sponsored by the U. S. Agency for International Development (USAID). The first phase of the program began in 2000 and will end at the end of 2003. Under the Energy Efficiency (EE) component, SARI/Energy has identified energy efficiency standards setting and labeling of end-use appliances as important to meet the ever-increasing demand for electricity, which is the biggest challenge faced by all SARI member countries.

EE Standards and labeling of end-use appliances have been proven as the effective tools to curb electricity demand in many countries. However, due to the poor penetration of EE appliances in most developing countries, there are a number of barriers to overcome such as lack of awareness of the benefits from the use of EE appliances, high initial cost of EE appliances, and the non-availability of EE appliances in the market.

Under the technical assistance component of SARI/Energy Program, NEXANT SARI/Energy is proposing to undertake a series of activities to promote Energy Efficiency Standards & Labeling of appliances in the region. The objectives of these activities are to:

- Assist the local Standards Institutions to understand the benefits from EE standards & labeling;
- Communicate the role and benefits from EE standards in competitive markets;
- Develop a mechanism and network for regional standards setting;
- Evaluate the benefits from regional testing facilities & recognize regional testing bodies for labeling, to support EE standards; and
- Establish a monitoring process to determine impacts.

1.2 THE ENERGY STANDARDS AND LABELING CONCEPT PAPER

Bangladesh has an opportunity to achieve significant energy savings at low cost by implementing energy standards and labeling strategies for a range of domestic appliances. However, there are several components of the program that need to be considered. To achieve a tangible result, the standards and labeling (S&L) programs require a lot of initiation and participation from various stakeholders, especially the key support from Government of Bangladesh. This concept paper aims to update the policy makers with the importance of S&L programs and its benefits; status of S&L programs worldwide, including case studies with cost and benefits; and key appliances for S&L programs in Bangladesh with potential benefits.

Section 2 Energy Standards and Labeling Programs

2.1 DEFINITIONS

Energy Standards and Labeling programs are cost-effective and proven methods for countries to cope with rapidly rising electricity consumption from the proliferation of electrical appliances in the domestic sector. Energy standards are a set of procedures and numbers that define the energy performance of manufactured products, sometimes prohibiting the sale of products where energy consumption is higher than the minimum standard. The term “standard” commonly encompasses two possible meanings:

1. A well-defined protocol (or laboratory test procedure) by which to obtain a sufficiently accurate estimation of the energy performance of a product in the way it is typically used, and;
2. A target limit on energy performance (usually a maximum use or minimum efficiency) formally established by an international agency or a widely recognized manufacturer association or a government-based agency upon a specified test standard. Minimum Energy Performance Standard (MEPS) is the common term for a energy standard that products must meet before they can be sold.

Energy labels, on the other hand, are the informative labels affixed to manufactured products in order to provide consumers with the data necessary for making informed purchases. They always serve as a complement to the energy standards. The energy labels indicate a product’s energy performance.

Figure 2-1: Endorsement Labels

Generally the energy labels are categorized into two broad categories; **Endorsement labels** and **Comparative labels**. Endorsement labels, as shown in Figure 2-1, are mostly of a voluntary nature and they serve as the approval seals from government agencies or institutions but the comparative labels can be of both voluntary and mandatory nature. The visual designs of comparative labels in use around the world, as shown in Figure 2-2, can be grouped into three basic types:

1. **Dial Type:** This type of label has a “dial” or gauge, with greater efficiency linked to advancement along the gauge (more efficient represented by a clockwise arc). This type of label is used in Australia, Thailand, and Korea and is proposed for India.
2. **Bar Type:** This type of label uses a bar chart with a grading from best to worst. All grade bars are visible on every label with a marker next to the appropriate bar indicating the grade of the model. This label is used primarily in Europe and South America.

3. **Linear Type:** This label has a linear scale indicating the highest and lowest energy use of models on the market, locating the specific model within that scale. This model is used in North America

There are also many other energy labels that have no graphic concept to support the indication of energy efficiency – these generally rely on text to explain the efficiency or some numeric indicator of efficiency. These labels are also called "Informative-Only Labels".

Figure 2-2: Comparative labels (bar, linear, dial and informative-only)

2.2 POTENTIAL BENEFITS

Energy standards and labels can play an important role in sustainable development in developing countries. Energy efficiency improvements through S&L strategies can slow the growth in electricity demand, reduce capital expenses for energy infrastructure and also provide savings to electricity consumers. For most developing countries, financing energy sector expansion is a significant burden on the economy and it has been proven that the cost of saving 1 kWh of energy through energy-efficiency programs is much less expensive than producing 1 kWh of energy through a new power plant. Energy S&L also offers practical and cost-effective ways to meet both in-country and global environmental objectives. For countries reliant on imported fossil fuels for power generation a decrease in electricity demand will save valuable foreign exchange, reduce local environmental impacts and conserve indigenous resources.

2.3 STATUS OF STANDARDS AND LABELING PROGRAMS WORLDWIDE

The status of energy S&L programs around the world and types of equipment and appliances included vary from country to country. Figure 2-3 illustrates the effective years of energy efficiency S&L programs around the world. The most recent updates of Asian S&L programs are given in Table 2-1.

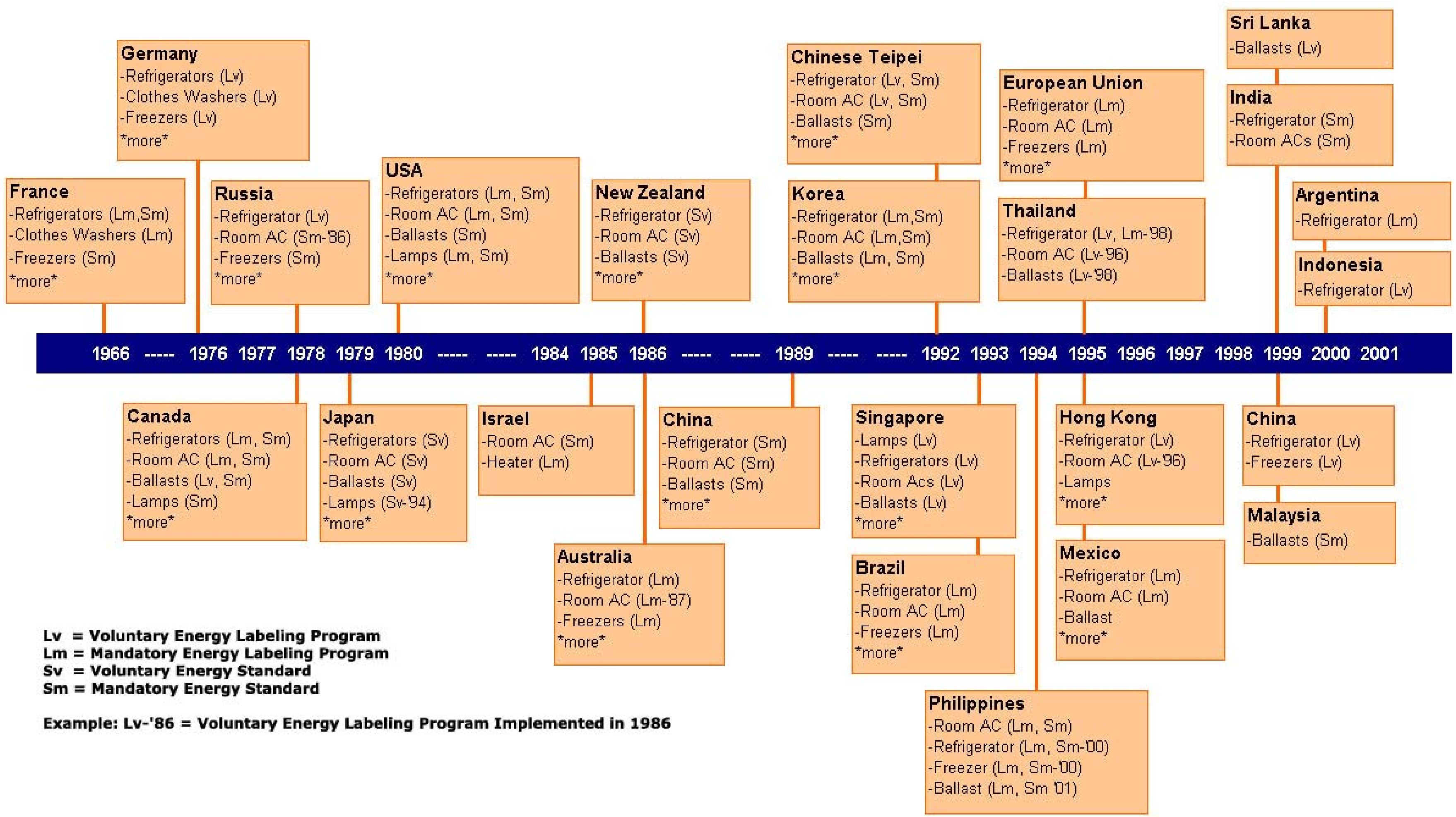


Figure 2-3: Standards and Labeling Around the World – Effective Years

Table 2-1: Recent Update of Asian Standards and Labeling Programs

Country	Energy Standards and Labeling Program	Remarks
India	Voluntary Energy Labeling	Products: Refrigerators and Freezers, label design was completed in late 1999. The Energy Conservation Bill to foster the development of Indian labeling program was approved by Government of India in 2001
	Voluntary Minimum Energy Performance Standards	Products: Refrigerators and Freezers (1999)
Sri Lanka	Voluntary Energy Labeling	Products: Ballasts (1999) and CFLs (2001)
Thailand	Mandatory Energy Labeling	Product: Refrigerators (Voluntary in 1995 and Mandatory in 1998)
	Voluntary Energy Labeling	Products: Air-conditioners (1996), Ballasts (1998)
	Mandatory Minimum Energy Performance Standards	Products: Compact Fluorescent lamps, Fluorescent tubes, Ballasts, Refrigerators, Air-Conditioners, Motors (2004)

2.3.1 India

Currently, India's power system has a peak demand deficit of around **14.5%** and transmission and distribution losses of approximately **23%**. This is in part due to the rapidly growing demand in the residential sector. India does not have an established S&L program at this stage. However, since the passage of the Energy Conservation Bill in August 2001, S&L is one of the priority programs to be implemented through the newly established Bureau of Energy Efficiency (BEE). The Bill legally authorizes the issue Minimum Energy Performance Standards (MEPS) and Labels for equipment and appliances. USAID collaborated with the Ministry of Power and the Bureau of Indian Standard (BIS) to research into the design and effectiveness of the label from 1997 to 1999. The label design process was an excellent example of how to develop a relevant national energy label and utilize considerable consumer and stakeholder input. A sample of the label design is given in Figure 2-4.

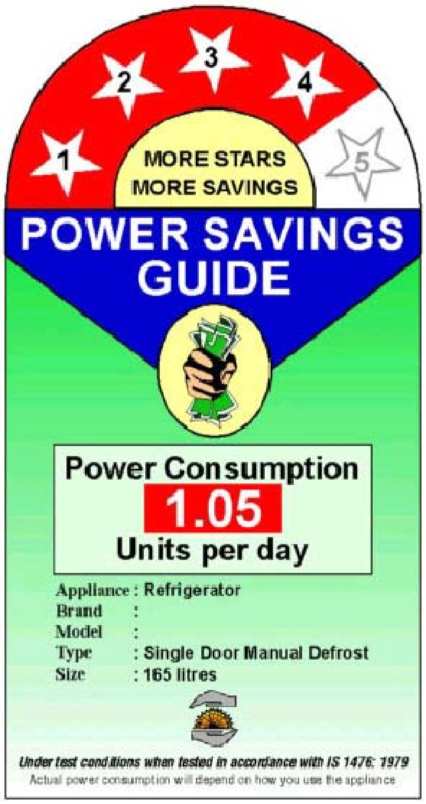


Figure 2-4: Indian Label Design

2.3.2 Sri Lanka

The Ceylon Electricity Board (CEB), in association with the Sri Lanka Standards Institute (SLSI), is currently implementing a ballast energy labeling program on a voluntary basis. The ballast labeling program targets suppliers and large commercial end-users. A sample of the label design is given in Figure 2-5. The National Engineering Research and Development Centre (NERD) will test sample ballasts as per the Sri Lanka standards. Additional testing facilities to support refrigerators are under consideration, to be funded by the World Bank.

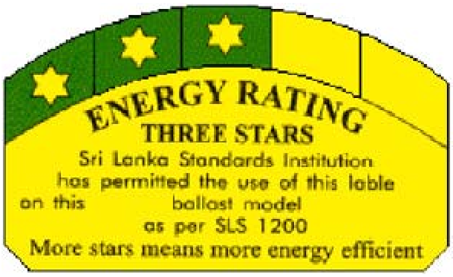


Figure 2-5: Sri Lanka Ballast Label

CEB also intends to seek further funding to cover testing facilities for other appliances, for example, air conditioners, motors, ceiling and table fans, and TVs. In addition to the ballast labeling program, CEB is also initiating a labeling program for Compact Fluorescent Lamps (CFLs).

2.3.3 Thailand

Following the success of the labeling programs for refrigerators, the Demand Side Management office (DSM) of the Electricity Generating Authority of Thailand (EGAT) reached an agreement with the manufacturers to raise the efficiency categories on the label for single-door refrigerators by **20%**, effective from January 2001. The success of the energy labeling programs led the government to fund the development of Minimum Energy Performance Standards (MEPS) for six types of products, i.e. refrigerators, air conditioners, compact fluorescent lamps (CFLs), fluorescent tube lamps, ballasts and electric motors. The government is expected to adopt the proposed standards in 2004. Sample of the Thai refrigerator label is given in Figure 2-6.

Figure 2-6: Thai Revised Label, 2000

2.4 SUMMARY OF SUCCESS STORIES

S&L programs are unique to each country. Some have implemented only standards; others only energy labels, and while some have implemented both. The Table 2-2 provides a summary of the achievements of a sample of countries.

Table 2-2: Summary of Successful Programs and Achievements

Country or Region	Program	Actual Results
Australia	Mandatory Standards and Labels	▪ **11%** reduction in energy consumption of labeled appliances (1992) ▪ Approximately equal to 630 GWh of saved energy or **1.6%** decrease in total household electricity consumption (1992) ▪ Estimated **12%** and **6%** lower electricity consumption of refrigerators and air conditioners respectively ▪ **14 - 33%** further reduction in refrigerator energy consumption with MEPS introduction
European Union	Mandatory Standards and Labels	▪ The average efficiency of the cold-appliance market has improved by approximately **27%** since the introduction of labels and MEPS. (1990/1992-1999) ▪ **6%** improvement on annual energy efficiency of refrigerators and freezers (1990/1992-1994) and an additional **4.5%** from 1994 to 1996 (only energy labeling program)
Korea	Mandatory Standards and Labels	▪ **39%**improvement in fluorescent lamp efficiency (1993-2000) ▪ **74%** decrease in refrigerator energy consumption (1993-2000) ▪ **54%** improvement in air-conditioner efficiency (1993-2000)
Philippines	Mandatory Standards and Labels	▪ **23%** improvement in energy consumption of all air conditioner units between 1992 and 1997 ▪ Energy Savings: 6 MW in demand and 17GWh in consumption (after first year)
Thailand	Voluntary Labels	▪ **12%** decrease in refrigerator energy consumption (1995-1999) ▪ Energy Savings: 168 MW in demand and 1,167 GWh in consumption. (as of June 2000)

Note: Details of successful programs are given in Appendix A.

Section 3 In-Country Information

3.1 ENERGY POLICIES AND REGULATIONS

3.1.1 National Energy Policy

The National Energy Policy (NEP) of the Government of Bangladesh was released in 1996 for the overall development of the Energy Sector. The main objectives of the NEP are to provide energy for sustainable economic growth, to meet the energy needs of the country, to develop the indigenous energy sources, to ensure sustainable use of energy sources, to develop energy sector without causing damage to environment and to promote public and private sector energy development simultaneously.

The NEP includes the power policy, which addresses demand forecast, long term planning and project implementation, investment, power distribution to the West zone as well as isolated and remote areas. In addition, the policy includes captive and stand-by generation, system loss reduction, load management and conservation, reliability of supply, system stability, load dispatching, and, most importantly, private sector participation. The policy also provides broad guidelines for power sector reform including the evolving structure of the industry and its regulations.

Power System Master Plan (PSMP), developed by the Bangladesh Power Development Board (BPDB), forecasts a doubling of installed generating capacity by 2005 at a cost of US$4.4 billion. The corresponding investment requirement for expansion and reinforcement of transmission and distribution system would be about US$2.2 billion for the same period.
The "*Private Sector Power Generation Policy of Bangladesh*" was also approved in 1996 to boost private sector power generation in the country. A Power Cell, under the Ministry of Energy and Mineral Resources (MEMR), was established in 1995 to coordinate private sector power development activities. The key functions of the Power Cell include evaluation of proposals, contract negotiation, contract award and administration.

3.1.2 Power Sector Demand-Side Policy and Programs

The short to medium term focus is electricity supply development considering its population (130 million), average economic growth of 5% per annum, low electrification rate, and high power demand growth (58% between 1990 and 1999). Although the development of demand side management (DSM) as a part of the energy efficiency strategy is one of the key components of power sector reforms, there are no clear guidelines or implementation plans as yet.

3.2 ELECTRICITY DEMAND AND SUPPLY

Currently, only around 18% of the population has access to electricity, and per capita commercial energy consumption is among the lowest in the world. During the past decade, especially from 1991 to 1996, the supply side has been unable to keep pace with the growth in demand. As a result, the country has faced serious power shortages, which has been a barrier to economic growth.

3.2.1 Structure of Power Sector

The Ministry of Energy and Mineral Resources (MEMR) of Bangladesh has the overall responsibility for the energy sector. Under the MEMR, there are three state-owned agencies responsible for the development of electricity in the country.

1. The Bangladesh Power Development Board, (BPDB) which is responsible for the generation and transmission of power and its distribution in the urban areas except Greater Dhaka.
2. The Dhaka Electricity Supply Authority, (DESA) which is responsible for the distribution of electricity in the Greater Dhaka area including the metropolitan city of Dhaka, and
3. The Rural Electrification Board, (REB) which is responsible for the distribution of electricity in the rural areas.

To enhance efficiency and competition in the power sector the Government of Bangladesh approved the creation of two new executing agencies in 1996, i.e. the Power grid Company of Bangladesh (PGCB) and the Dhaka Electric Supply Company (DESCO). PGCB is currently responsible for the operation of a section of the grid network and ultimately will be responsible for the total transmission system. DESCO is responsible for the distribution of electricity in Mirpur of the Dhaka metropolitan area.

3.2.2 Electricity Supply

Bangladesh's installed electricity generating capacity in 2001 was 3,770 MW, of which around 90% is thermal, mainly natural gas fired, and the remaining are hydro and diesel oil generation. There have been delays in the implementation of the power development plan and around 30%-40% of the existing power plants require refurbishment in the near future. In addition, transmission and distribution losses (system losses) are currently averaging 25%. Furthermore, not all installed capacity is available and as a result, the generation plants have been unable to meet system peak demand and required system reliability. The recorded available capacity in April 2001 was only 2,850 MW.

Table 3-1: Total Installed Capacity

Generating Plants	MW
BPDB	3320
IPP	450
Total	**3770**

Source: BPDB (IPP: Independent Power Producer)

3.2.3 Electricity Demand

The PSMP's forecast average annual demand growth is about 8% between 1995 and 2015, however, due to the shortage of generation, the annual demand growth from 1995 to 1997 was only around 7%. The maximum demand in August 2000 was 2,750 MW against 3,150 MW previously forecast. The maximum demand in Bangladesh does not reflect the real demand but the generation capacity.

Approximately 18% of the population (25% in urban areas and 10% in rural areas) has access to electricity, and per capita commercial energy consumption is among the lowest in the world. The number of electricity consumers is around 5 million and consumers in greater Dhaka area account for about 36% of total electricity consumption. Electricity demand in Bangladesh sharply increases during evening peak hours mainly due to the increased consumption from the residential sector (Figure 3-1), and, due to generation shortages, load shedding during the evening peak period is a regular occurrence. The total consumption by sector in 2000 is given in Figure 3-2.

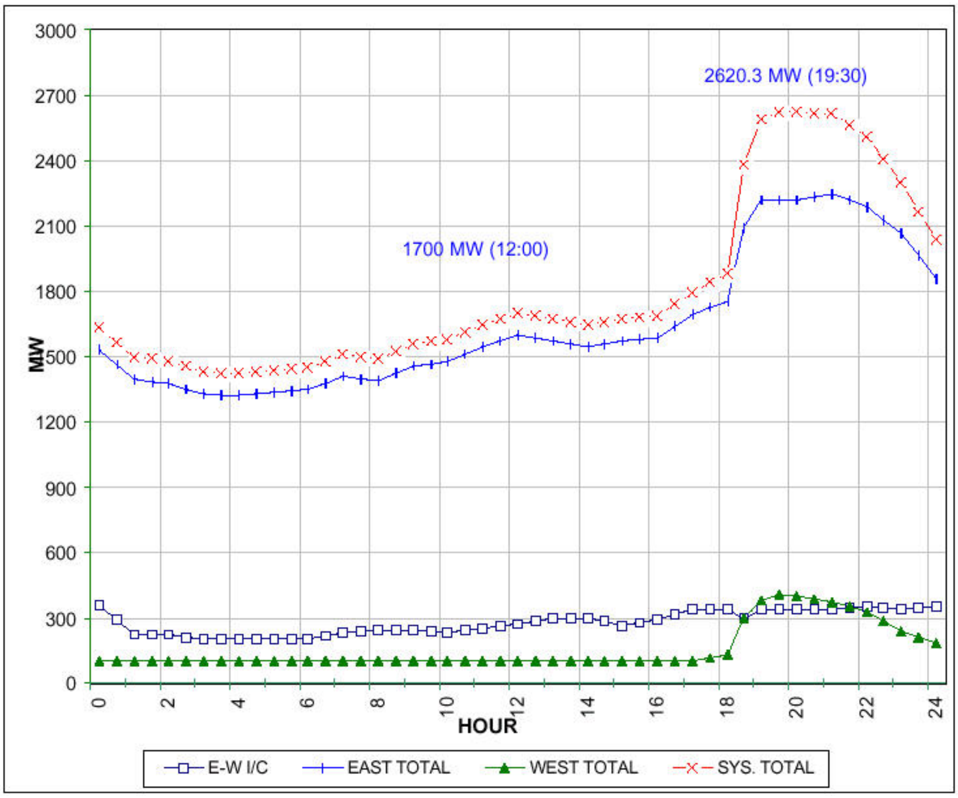


Figure 3-1: Daily Load Profile - April 2000, source: BPDB

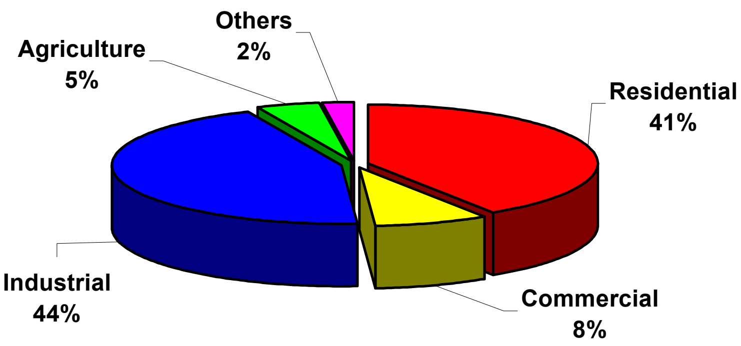


Figure 3-2: Consumption by sectors, 2000, source: BPDB

3.2.4 Power Development Plan

The "Private Sector Power Generation Policy of Bangladesh" approved in 1996, and the Power Systems Master Plan have resulted in solicitations for a number of fast-track barge-mounted plants, for example a 360-MW plant at Haripur, a 450-MW plant at Meghnaghat, and a 100-MW gas-fired plant at Baghabari. These plants were scheduled for commissioning in 2001. The total generation capacity including existing, under construction and planned, in 2007 is expected to be about 7.74 GW, of which IPP capacity will be around 2.05 GW. In 1998, Bangladesh adopted a "Small Power Generation Policy," and the country also has an aggressive Rural Electrification program. All these initiatives are aimed to increasing power generation capacity with a goal of achieving total electrification by 2020.

3.3 ELECTRICAL APPLIANCES – TYPES AND SATURATION

There is no available statistical data on electrical appliance consumption in Bangladesh, but, with only 5 million electricity consumers out of a total 23 million households, the percentage of home appliance usage is very low. The statistical data from 1993 to 1999 provided by Bangladesh Bureau of Statistics shows that the number of consumers in residential sector is about 70% of total electricity consumers and accounts for about 40% of the country's total electricity consumption. The home appliances that serve primary needs such as lighting, cooling and entertainment are among the most popular in Bangladesh. Electricity consumption from these household appliances used during 18.00-24.00 is evidently shown in the daily load profile. They currently account for an additional 500 to 600 MW to the evening demand.

According to local and international lighting suppliers, 60-80 million units of lamps are sold in Bangladesh each year, of which 90% are incandescent lamps, 9% are fluorescent tubes and 1% is Compact Fluorescent Lamps (CFLs). The growth of the lighting market in Bangladesh has been curbed by the quality and availability of electricity but significant growth is expected once the current supply situation is addressed. The best estimates of the percentage of appliances in domestic household are given in Table 3-2 below.

Table 3-2: Electrical Appliances – Types and Saturation

Appliances	Household Saturation (%)
Lamp	20%
Television	3%
Fan	N.A
Refrigerator	N.A
Air-Conditioner	N.A

Source: Bangladesh Bureau of Statistics and industry interviews

4.1 SELECTED APPLIANCES

Among primary household appliances, all electricity consumers use either incandescent or fluorescent lighting. Based on limited sales data available, it appears that incandescent lamps[3] dominate the market. Based on experiences in other countries, it is considered that S&L for fluorescent lighting would yield the greatest benefits to Bangladesh. In addition to lighting, the impact of two other appliances – rice cookers and refrigerators were considered. In the absence of statistical appliance data from Bangladesh, appliance efficiency gains from similar programs in other countries were used in the analysis.

4.2 ELECTRICITY DEMAND AND ENERGY IMPACT

The electricity demand and energy impacts from S&L programs for lighting, rice cookers and refrigerators were analyzed for two scenarios, as described below. The variables considered in the two scenarios are only for lighting, while the impacts S&L of rice cookers and refrigerators remain constant. The assumptions made for the impact analysis are given in Appendix B.

4.2.2 Scenario I

Bangladesh introduces an energy standard that prescribes minimum quality, efficiency and lifetime for Compact Fluorescent Lamps (CFLs)[4] that are both imported and locally manufactured. In addition, an energy labeling program is introduced for CFLs, supported by a public awareness campaign to promote efficient lighting. As a result of the S&L programs, the CFLs will penetrate the incandescent lamp market share at the rate of 10% per annum.

4.2.2 Scenario II

Bangladesh introduces a more aggressive S&L program for CFLs and as a result CFLs will penetrate the incandescent lamp market share at the rate of 15% per annum. In addition to the CFL program, Bangladesh also introduces an S&L program for fluorescent tubes[5] and the market of 40W fluorescent tubes (T12) will be totally transformed into the 36W fluorescent tubes (T8) within 5 years.

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[3] An incandescent lamp works by heating a filament, a double-spiral coil of very thin tungsten wire, with an electric current until it radiates visible light. Modern tungsten filaments operate at about 2,500° C and, at that high temperature the lamp life is around 1,000 hours. Because only around 12% of the thermal radiation is visible, an incandescent lamp can deliver only 11-14 lumens per watt.

[4] Compact fluorescent lamps (CFLs) are miniaturized versions of fluorescent tube lighting. Some units consist of a lamp and separate ballast, while others have the ballast built in. CFLs are designed with the bases that can directly fit into the conventional sockets for incandescent lamps. CFLs produce more light for less power and typically last for 6,000 to 8,000 hours. A good CFL will deliver 55-60 lumens per watt, compared to 11-14 lumens per watt for an incandescent lamp, thus an equivalent energy saving of around 80%.

[5] A fluorescent tube or a fluorescent lamp is an electric discharge lamp that generates light from a phosphor-coated tube. To operate a fluorescent lamp, a device called "ballast" must be equipped in the lighting circuit. The fluorescent lamps come in a wide range of lengths and a number of different diameters. The older fat "T12", or 1.5-inch (38 mm) diameter tube is less efficient than the thinner "T8", or 1.0 inch (26 mm) diameter tube. T8 tubes paired with electronic ballasts can reach efficiencies approaching 100 lumens per watt, while the older technologies may yield about 65 lumens per watt.

4.3 Benefits

With the introduction of an energy S&L program covering fluorescent lighting, rice cookers and refrigerators complemented by a public awareness campaign to promote efficient appliances, Bangladesh could potentially save between 500 MW to 700 MW[6] in peak demand over a five-year period. Considering the high transmission and distribution losses, this corresponds to a generation capacity saving between 625 MW to 875 MW or more than Tk. 48 billion[7] capital investment in new capacity. The corresponding reduction in energy consumption is estimated at 2,800 GWh or Tk. 11 billion[8] over the five-year period.

Impacts of the S&L programs as per scenarios I and II are illustrated in Figure 4-1 and Figure 4-2, and details of the analysis are given in Appendix B.

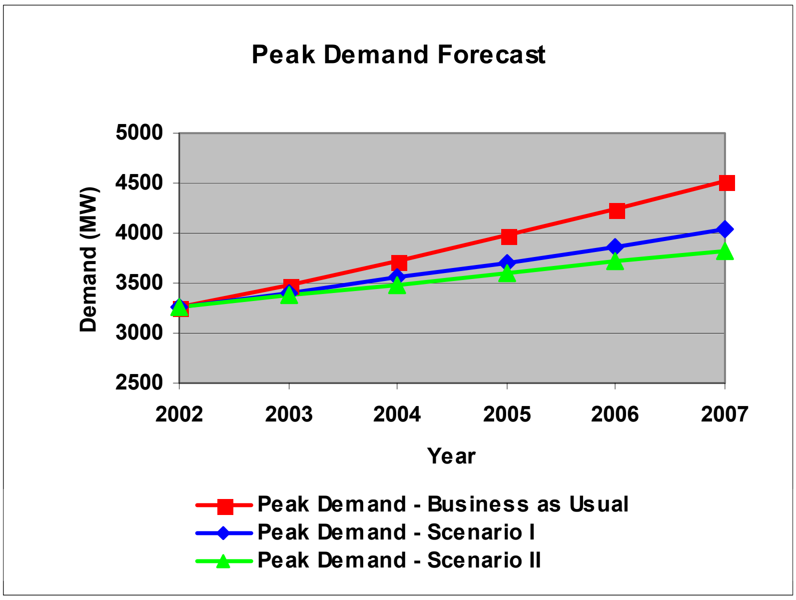

Figure 4-1: Impacts of S&L programs on Electricity Peak Demand, source: IIEC

[6] The potential 500 to 700 MW peak demand saving is conservatively estimated from daily usage patterns of energy efficient rice cookers (2hrs/day) and refrigerators (5hrs/day cycling), and the use of energy efficient lamps during the evening peak hours (4hrs/day). See details of the analysis in Appendix B

[7] Due to 25% transmission and distribution losses, 500 to 700 MW peak demand is equivalent to 625 to 875 MW generating capacity (500 to 700 MW x 125%). Based on existing power plant construction, it is estimated that each MW of power plant costs US$ 1 million, so Bangladesh requires US$ 875 million or Tk. 48 billion to build 875 MW power plant (US$1.00 = Tk. 55). See details of the calculations in Appendix B.

[8] Based on BPBD's average electricity cost at Tk. 4.00 per kWh, a cumulative saving of 2,800 GWh of energy over five-year period will save Tk. 11 billion paid by consumers. See details of the calculations in Appendix B.

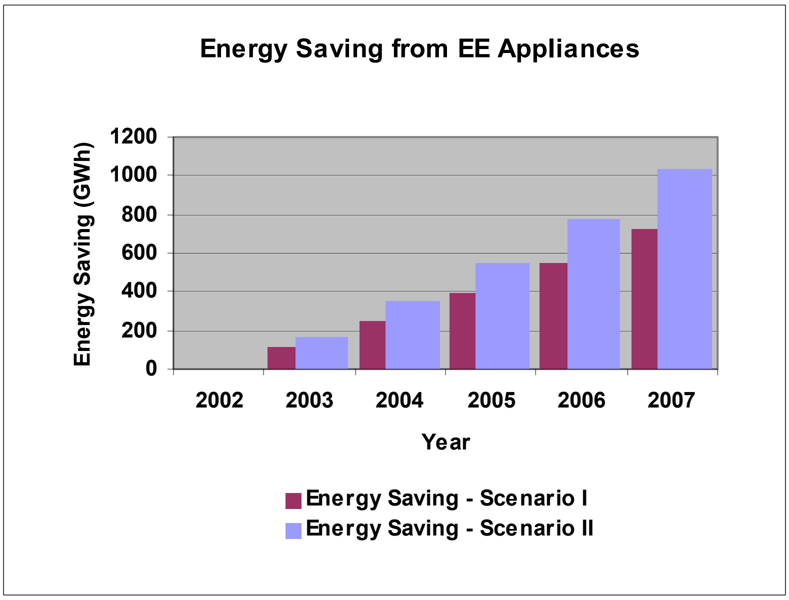

Figure 4-2: Impacts of S&L programs on Energy Saving, source: IIEC

The analysis in Section 4 reveals the enormous benefits of a S&L program for lighting, rice cookers and refrigerators in Bangladesh. In addition, S&L programs in other countries for other domestic appliances such as electric fans, ballasts, room heaters and water heaters, have shown to yield significant benefits. However, due to limited information available on other appliances, the analysis of the benefits of S&L could not be undertaken.

To broaden the perspective of benefits of appliance S&L programs, it is therefore necessary for Government of Bangladesh to consider gathering more information on appliance saturation and end-use consumption in different segments of the residential sector. Market Research to determine customer awareness, appliance types and purchasing preferences is also recommended.

In order to establish a sustainable S&L program, the following steps are recommended:

1. Establish a Steering Committee with the responsibility of setting energy efficiency standards and labeling for appliances. Such a committee should ideally comprise of representatives from the following major stakeholders:

- Bangladesh Standards and Testing Institution (BSTI)
- National Board of Revenue (NBR), Ministry of Finance
- Ministry of Industries
- Ministry of Science and Technology
- Ministry of Energy and Mineral Resources (MEMR)
- Bangladesh Power Development Board (BPBD)
- Rural Electrification Board (REB)
- Dhaka Electric Supply Authority (DESA)
- Power Cell
- Bangladesh Center for Advanced Studies
- Bangladesh National Scientific and Technical Documentation Center
- The Center for Energy Studies, Bangladesh University of Energy and Technology (BUET)
- Dhaka Chamber of Commerce

2. The Steering Committee prepares a Plan of Action for S&L over a specified period
3. Conduct a detailed feasibility study to include – market surveys on customer awareness and preferences, appliance saturation and usage profiles, scope of appliance efficiency gains, detailed cost and benefit analysis, institutional framework for S&L, and power system characteristics that are likely to impact on S&L
4. Establish a mechanism to harmonize standard setting and labeling programs with ongoing programs in neighboring countries

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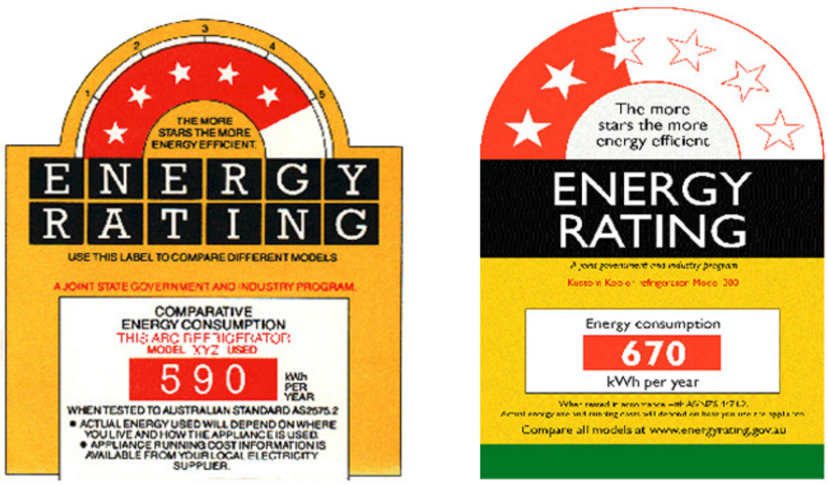
Appendix: A

AUSTRALIA

Energy Standards and Labeling Program

The energy labeling and standards program in Australia originated in 1982, when the Government of the State of New South Wales (NSW) first realized the energy saving from energy efficient appliances such as refrigerators and freezers. In 1985, after unsuccessful attempts to introduce a nationwide voluntary scheme, the NSW and Victorian governments regulated for the mandatory energy labeling of refrigerators, freezers, dishwashers and air conditioners. Australia's two largest cities, Sydney and Melbourne, account for some **60%** of the national appliance market. The mandatory energy labeling for refrigerators and freezers became effective in 1986. Labels were later introduced for room air-conditioners and dishwashers in 1987 and 1988 respectively. Now the remaining States have adopted these energy labels. To complement the energy labeling program, the Minimum Energy Performance Standards (MEPS) for refrigerators, freezers and electric storage water heaters were introduced in 1999. MEPS for three phase packaged air conditioners and three phase electric motors will be implemented in 2001/02. Fluorescent lamp ballast MEPS are under consideration for 2003.

The energy labeling program in Australia has been successful because suppliers perceived a commercial value in having 5 star products (more stars denote more efficiency). Once products have reached 5 stars, the incentive for suppliers to introduce better efficient models was reduced. Following several years of negotiation, between government and industry, the Energy Rating Label was revised in 2000, increasing the efficiency levels needed to obtain equivalent star rating. For example, 4 stars under the old system may now only rate 2 or 3 stars under the new (Figure A-1).



Original Australian Label (1986) **Revised Australian Label (2000)**

Figure A-1: Australian original and revised labels

Implementation Structures and Costs

In Australia, labeling and MEPS programs are controlled by the State rather than the national legislation. The labeling program requires the cooperation of several organizations. Firstly, each State and Territory Government is responsible for legislation, regulations and administration. This includes the requirement for labels to be displayed and regulating offences and penalties account for non-compliance in this area. Secondly, in order to gain consistency across the country, the National Appliance and Equipment Energy Efficiency Committee (NAEEEC) has been established to provide a coordinating role for the program. NAEEEC determines policy and sets the future directions for labeling. Finally, Standards Australia is charged with establishing test procedures. They also publish special regulatory standards that show how to calculate ratings and configure the labels and specify other program requirements.

It is mandatory for manufacturers and importers to register energy labels for designated appliances before retailers in Australia can sell them. The costs of energy performance testing as well as producing and fixing labels incurred to the industry are passed on to consumers. However, the uncertainty in average purchase price is far greater than the share of the price made up by labeling costs.

All administration costs for the program that burden government or electric utilities are also passed on to consumers. These costs include administration costs to cover policy and regulation, costs of check testing and costs of promotion. The costs of promotion include the cost of retail liaison staff employed as well as production and distribution of guides and leaflets.

Results

The Australian energy labeling program has been very successful. Among randomly selected appliance buyers who participated in a 1993 survey, nearly **90%** were aware of the energy label and **45%** used the information on the label to compare models on the market. In another survey (1991), it was found that **28.4%** of respondents considered the energy-efficiency rating to be the most important factor when purchasing a new electrical appliance. The energy labeling program has been attributed to reducing energy consumption of the labeled appliances by an estimated **11%**, or 94 GWh, in 1992.Refrigerators and air conditioners consumed **12%** and **6%** lower electricity, respectively. This amounted to a **1.6%** decrease in the total household electricity consumption in Australia. With an introduction of MEPS, a further reduction of between**14%-33%** in refrigerator energy consumption has been achieved.

EUROPE

Energy Standards and Labeling Program

After 16 years of debate, the European Commission (EC) enacted a Framework Directive for mandatory energy labeling in 1992. This grants the EC authority to issue energy labels for appliances (refrigerators, freezers, air-conditioners, washing machines, clothes dryers, dishwashers, ovens, water heaters, and lighting sources) without seeking additional political approval from the Council of Ministers or the European Parliament. It is the responsibility of each individual Member State to translate directives into laws, only then, the labeling requirement become mandatory. In terms of legal implementation, all 15 EU Member States have now implemented the directives, but most were late in doing so. Only four countries met the implementation deadline of January 1995, additional seven countries completed the procedure within one year after the deadline, the remaining four were staggered over the next three years. The last country implemented it in October 1998. The EU appliance energy labels all follow a similar format. The energy efficiency of a given appliance is ranked into one of 7 bins graded from A to G, A being the *most efficient* and G being the *least efficient*.

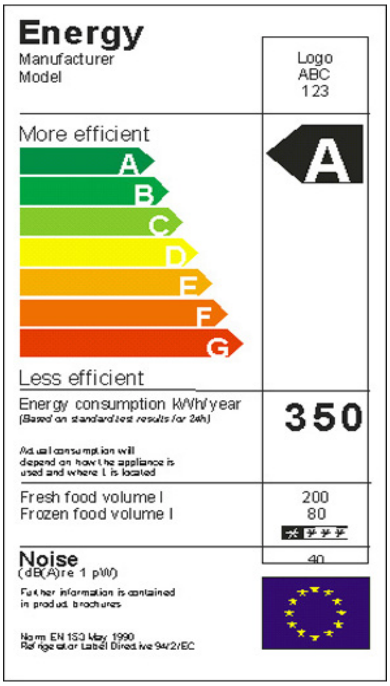


Figure A-2: European Label

There has also been attempts to improve appliance efficiencies in a non-regulatory manner but those efforts are not united. Another EC directive in 1992 allowed for the introduction of a EU wide eco-labeling scheme. This voluntary program covers several appliances, which must meet energy efficiency criteria. The eco-label can be incorporated into the design of the comparative label.

Unlike energy labeling, there is no framework legislation giving the Commission to introduce or revise energy efficiency standards on an on-going basis. European Union members need to gain approval from the EC and the Parliament in order to introduce or revise mandatory energy efficiency standards for any product. To date only two appliances have mandatory standards. MEPS for domestic gas or oil fired hot water services were approved in 1992, taking effect in 1998, and the refrigerator and freezer MEPS, which was approved in 1996 and took effect in 1999. The parliament has also recently approved a proposal covering MEPS for Fluorescent Lighting Ballasts.

Implementation Structures and Costs

Member States are responsible for all aspects of implementation including compliance, label accuracy, educational and promotional activities. Product suppliers need to provide proof of appliance efficiency and are also responsible for the supply of labels and brochures in appropriate languages.

Results

The mandatory nature of the program has spurred manufacturers to improve the efficiency of their products. In Germany, for example, the efficiency of products in the market improved by **16.1%** from 1993 to 1996, while the efficiency of products in the market in Netherlands improved by **12.6%** from 1992 to 1995. In the United Kingdom, efficiency of refrigerator-freezers increased by **7.3%** between 1994 and 1996. The current trend in the EU suggests that the program is expected to save 278 TWh between 1996 and 2020 for refrigerators, freezers, and refrigerator/freezers alone; this is roughly a **10%** decrease in projected electricity demand for these appliances. The estimated savings translate into more than

US$40 billion in avoided electricity spending for consumers, if constant real electricity prices are assumed.

PHILIPPINES

Energy Standards and Labeling Program

After years of co-ordination with manufacturer associations and the Department of Trade and Industry's Bureau of Product Standards (BPS), Department Of Energy (DOE) launched the Standards and Labeling program in late 1993, and began labeling air conditioners in early 1994.Air conditioners, both imported and domestic models are required to meet a minimum efficiency standard and are to be labeled. Air conditioners are given priority because, while only penetrating a small fraction of households, they represent one of the fastest growing electricity end-uses in the residential sector. In 1997, the standard was tightened so that the Energy Efficiency Ratio (EER) increases 5 percent every three years until 2002.In late 1999, the Fuels and Appliance Testing Laboratory (FATL) launched the energy labeling program for refrigerators and freezers and the program became mandatory in 2000.The mandatory energy standards and labeling of electromagnetic fluorescent ballasts and split-type air-conditioners will begin in 2002.

Figure A-3: AirCon and Ballast label

The energy label for single-package room air-conditioners is detailed information design (Figure A-3). The label was designed by FATL and approved by the technical committee but no marketing consultations took place.

Implementation Structures and Costs

The DOE, BPS and the Association of Home Appliance Manufacturers (AHAM) jointly administered the AirCon program, while BPS is responsible for enforcing the standards. DOE also established the Fuels and Appliance Testing Laboratory (FATL), serving as a neutral testing laboratory to verify manufacturers' assertions of the efficiency of their units. The annual operating cost of FATL is about US$160,000 to $200,000 and the initial construction of the laboratory cost US$675,000. The average price of an air conditioner increased by US$30, about **5%** of a unit's total cost, due to the program.

The DOE also administers the public awareness campaign. One of DOE's most recent initiatives is a nationwide campaign, known as POWER PATROL, an awareness-building campaign initiated by the private sector and supported by the government. The campaign gives emphasis and brings into focus the significance of power conservation and the efficient use of electricity and energy through the Committee on Power Conservation and Demand Management (CPCMD). To push the campaign to cover all sectors, the CPCDM formed three task forces which serve as its implementing arms: a task force for schools and educational institutions, a task force for commercial and industrial establishments and a task force for household and villages.

Results

Before the program started, only half of the annual sales volume for small-sized, window-type air conditioners met the standard, while none of the larger units did. By forcing these units off the market, the program had an immediate and pronounced effect in the overall efficiency of air conditioners in the market. Due to the “push” of standards and the “pull” of labels, an analysis, conducted by FATL, suggests an improvement of **23%** in energy consumption of all air-conditioning units between 1992 and 1996. Estimates of the program are preliminary at best, but it appears that the standards component of the program resulted in first-year capacity savings of 6 MW and energy savings of over 17 GWh. The estimates do not incorporate efficiency improvements in split systems or from the labeling component of the program. The impact of the program will increase with time because the number of air conditioners in the country is rising dramatically. In 2000, the average EER of Room Air Conditioner (RAC) products sold was 10.1 for below 12,000 kJ/h and 9.6 for above 12,000 kJ/h.

SOUTH KOREA

Energy Standards and Labeling Program

A surplus of electric power capacity in summer in Korea abruptly dropped down from 52% in 1987 to **5%** in 1991.[9] Major appliances, except air conditioners, are already saturated in the market. The saturation of room air conditioners has rapidly increased. The energy standards and labeling program was introduced in 1992, and it has played a key role particularly in curbing the steep growth of electricity consumption. In the beginning, 6 items were included in the program, i.e. refrigerators and freezers, room air-conditioners, incandescent lamps, fluorescent lamps, ballast and passenger cars. The energy efficiency standards program consists of mandatory energy efficiency rating label, Minimum Energy Performance Standard (MEPS) and Target Energy Performance Standard (TEPS). MEPS is mandatory; TEPS is voluntary.

The rating label established a 5-rank system for labeling the energy use of appliances. <u>The most energy efficient models</u> (products that correspond to TEPS) receive a <u>grade 1</u>, and <u>the least efficient models</u> (products that correspond to MEPS) receive a <u>grade 5</u>.

Figure A-4: Korean Label

Implementation Structure and Costs

The Ministry of Commerce, Industry and Energy (MOCIE) established the Korean Energy Management Corporation (KEMCO) to implement energy

9 CLASP February 2001- Energy Efficiency Labels & Standards- “ A Guidebook for Appliances Equipment and Lighting”.

efficiency and conservation programs in 1980. MOCIE is responsible for establishing the framework for the program such as setting/revising and announcing standards. KEMCO is also charged with implementation and monitoring of the program. Korea Institute of Energy Research (KIER**)** is mainly involved in standards setting, in consultation with MOCIE, KEMCO, and the manufacturers and importers, and formulates energy efficiency standards and rating labeling rules.

The energy tests are detailed in Korean Industrial Standards (KS), which are closely related to equivalent Japanese Industrial Standards (JIS) and/or IEC standards. Eight laboratories and research institutes provide testing services in support of the standards and labeling programs. Upon testing the product, the testing laboratory provides the manufacturer or importer with an official efficiency level which the manufacturer or importer then reports to KEMCO.

Results

The survey in 1994 and 1996 by KEMCO has shown that

- The program has very high visibility and recognition.
- **85%** of general consumers and **96%** of appliance purchasers were aware of the label.
- **72%** said they used the information to compare appliances prior to purchase.
- The result of survey gave energy efficiency equal importance with other key appliance characteristics such as price, function, brand and size.

The percentage of energy efficient appliances in the market (grade 1 or grade 2) has steadily increased from **53.3%** in 1993 to **67.5%** in 2000, in spite of the reinforced and higher level energy efficiency standards and rating in 1996, 1999, 2001 for each product. Between 1993 and 2000, refrigerators and air-conditioners have shown an improvement in efficiency of **74%** and **54%** respectively.

THAILAND

Energy Standards and Labeling Program

Thailand has energy efficiency labeling programs for refrigerators, air conditioners and ballasts for fluorescent lamps under the national DSM plan. All programs are entirely voluntary and are not associated with a program to set minimum energy efficiency standards. Thailand's Electricity Generating Authority of Thailand (EGAT), the national generating utility, administers the programs through its DSM Office. EGAT established voluntary labeling programs for the two largest energy-consuming appliances in the residential sector – refrigerators and air-conditioners in 1995 and 1996 respectively (Figure A-5). The energy efficient ballast labeling program was introduced in 1998. Currently, the Thai government is enhancing the success of voluntary labeling programs by establishing minimum efficiency performance standards (MEPS) for air-conditioners, refrigerators, ballasts, compact fluorescent lamps (CFLs), fluorescent lamps (FLs) and motors.

The efficiency scale on the label for each model is 1 to 5, with 5 being the most efficient. Starting from January 2001, the efficiency level of each category on single-door refrigerator label was increased by **20%**.

Administrative Structure and Costs

Aside from EGAT, other government institutions involved in setting up standards and labeling programs include: the National Energy Policy Office (NEPO), the Thailand Industrial Standard Institute (TISI), the Department of Energy Development and Promotion (DEDP) and the Office of Consumer Protection (OCP). NEPO has the mandate to formulate national energy policy while DEDP is responsible for implementing the policy. Both NEPO and DEDP have the legal authority to issue energy efficiency standards and labels. Testing for EGAT's voluntary labeling programs for refrigerators and air-conditioners is done at Thai Industrial Standard Institute (TISI).

EGAT has allocated US$ 7.8 million for the refrigerator program and US$47 million for the air-conditioner program. EGAT launched a consumer awareness campaign promoting the importance of saving energy to complement the energy labeling programs and became one of the largest advertisers in Thailand during 1995 - 1996. In addition to the EGAT nationwide television campaign, the manufacturers also launched promotional campaigns emphasizing the energy-saving benefits of their products.

Original Thai Label (1995) Revised Thai Label (2001)

Figure A-5: Thai original and revised labels

Results

The success of the programs was due both to market pull from consumer demand and market push from the voluntary agreements made by manufacturers. When the refrigerator labeling program began in 1995, only one model earned a "5" rating. Out of the participating refrigerators (i.e. refrigerators for which manufacturers requested labels), **33%** were rated at 3, **55%** were rated at 4, and **12%** were rated at 5. Share of "5" rating refrigerators increased from **12%** in 1995 to **96%** in 1998. The average energy consumption of participating refrigerators dropped by **12%** between **1995 and 1999. Share of "5" rating air-conditioners also increased from 19% in 1996 to 38**% in 1998.

As of June 2000, EGAT estimated that the refrigerator and air-conditioner labeling programs have reduced 168 MW in peak demand and 1,167 GWh in energy consumption. These figures have exceeded EGAT's initial expectations by more than three times.

Appendix : B

ASSUMPTIONS USED IN THE ANALYSIS

Due to the lack of comprehensive appliance consumption data, the analysis of impacts from the energy efficiency standards and labeling programs gives emphasis to only domestic appliances given in Table B-1.

Table B-1: Types of appliances included in the analysis

Appliance	Estimated Units in Operation (million)
Incandescent lamp (40W)	27
Fluorescent lamp (T12, 40W)	2.7
Compact Fluorescent lamp (10W)	0.15
Rice Cooker (500W)	1.9
Refrigerators (250W)	0.25

Source: Industry interviews and estimation

Reduction of electricity peak demand from 2002 to 2007 resulting from a S&L program for lighting, rice cookers and refrigerators, and the corresponding energy savings is derived from the accumulation of decreased energy consumed due to energy efficient appliances over the next five years. The assumptions used in the analysis are given in the table below:

Table B-2: Assumptions for Impact Analysis

Particular	Assumption	Basis or Source
Average Energy Cost	Tk. 4.00/kWh	BPBD's annual report
Power Plant Construction Avoided Cost	US$ 1 million/MW or Tk. 55 million/MW (US$ 1.00 = Tk. 55)	Based on the construction costs of 110 MW Khulna Steam power plant and 360 MW AES Haripur power plant
Daily load profile	Same pattern for over next 5 years	BPBD's statistical data
Electricity demand growth	8% per annum	BPBD's forecast
Appliance market growth	6% per annum	
Electrified household (2001)	5	BPBD's statistical data
Number of Incandescent Lamps per household	4 Units	
Pattern of Lamps used in electrified household	Ratio Incandescent/fluorescent tube/CFL = 9/1/0.1	Industry interviews
Lamps wattage and daily burning hours	Incandescent lamps = 40W CFLs = 10W T12 Fluorescent tube = 40W T8 Fluorescent tube = 36W Daily burning hours = 6 hrs.	A fluorescent tube is equipped with a standard ballast (10W) in each lighting circuit.

Average Rice Cooker Wattage and daily usage hours	Standard Model = 500W Energy Efficient Model = 450W Daily usage hours = 2 hrs. (1 hr. in the morning and 1 hr. in the after noon)	Based on average daily kWh consumed of standard rice cooker in Thailand and the energy efficient model is 10% more efficient than the standard model.
Average Refrigerator Wattage and daily usage hours	Standard Model = 250W Energy Efficient Model = 220W Daily usage hours = 5 hrs.	Based on average daily kWh consumed of standard and energy efficient refrigerators in Thailand
Coincidence Factor	Lamps = 0.8 Televisions and rice cookers = 0.5 Refrigerators = 0.25	
Penetration rate of 10W (average) CFLs to 40W (average) incandescent lamp market	Scenario I: 10% per annum Scenario II: 15% per annum	
Penetration rate of 36W fluorescent tubes to 40W fluorescent tube market	Scenario I: 0% per annum Scenario II: 20% per annum	
Penetration rate of 450W rice cookers to 500W rice cooker market	Scenario I: 10% per annum Scenario II: 10% per annum	
Penetration rate of 250W refrigerators to 220W refrigerator market	Scenario I: 10% per annum Scenario II: 10% per annum	

ENERGY SAVING AND BENEFITS CALCULATION

Given the limitation of end-use data of electrical energy and appliances, the energy saving calculations is based on the daily load profile and number of key appliances in operation during the system peak period rather than the household saturation of each appliance, unit energy consumption of each appliance and number of households. The following equations are used in the calculation of electricity peak demand and energy demand for the appliances included in the analysis.

Electricity Peak Demand (MW) = Σ [Number of each type of appliances in operation during the evening peak (in million) x Average nominal wattage (W) x Coincidence Factor] + Average daytime demand (MW) (1)

Energy Demand During the Evening Peak hours (GWh) = [4 x Σ Electricity Peak Demand generated by each type of appliances (MW)]/1000 (2)

Daily Energy Demand (GWh) = [Daily operating hours x Number of operating appliances (in million) x Average nominal wattage (W)]/1000 (3)

The equation (2), derived from linear regression method, is limited to only the calculation of GWh generated by lamps during the evening peak hours, while the equation (3) is used for the calculation of daily GWh from rice cookers and refrigerators.

Potential Peak Demand and Energy Saving

The potential 500 to 700 MW peak demand saving and 2,000 to 2,800 GWh cumulative energy saving over 5-year period, shown in Table B-4, are conservatively estimated from the assumptions on daily usage pattern of energy efficient rice cookers and refrigerators, and the use of energy efficient lamps during the evening peak hours as per current system load profile. Number of energy efficient appliances increases as per assumptions in scenario I and II. The analysis of benefits from energy S&L programs in this concept paper do not include the electricity saving from the use of efficient lamps during off-peak hours and other indirect social, environmental and economic benefits.

Financial Benefits

Peak Demand Saving	= 500 to 700 MW	
Transmission and Distribution Losses	= 25%	
Generation Capacity Saving	= 500 to 700 MW/(125%) = 625 to 875 MW	(4)
Hydro Power Plant Avoided Costs	= Tk. 55 million/MW	(5)
Total Hydro Power Plant Avoided Costs	= (4) x (5) = **Tk. 34 to 48 billion**	(6)
5-Year Cumulative Energy Saving	= 2,000 to 2,800 GWh	(7)
Average Electricity Cost	= Tk. 4.0/kWh	(8)
5-Year Consumers' Electricity Cost Saving	= (7) x (8) = **Tk. 8 to 11 billion**	(9)
Total Benefits	= (6)+(9) = **Tk. 42 to 59 billion**	

Table B-3: Calculation of Peak Demand and Energy Saving

Peak Demand: Base Case	2001			2002			2003			2004			2005			2006			2007		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	27.0	864.0	3.46	28.6	915.8	3.66	30.3	970.8	3.88	32.2	1029.0	4.12	34.1	1090.8	4.36	36.1	1156.2	4.62	38.3	1225.6	4.90
Fluorescent tubes (40W)	2.7	108.0	0.43	2.9	114.5	0.46	3.0	121.3	0.49	3.2	128.6	0.51	3.4	136.3	0.55	3.6	144.5	0.58	3.8	153.2	0.61
CFLs (10W)	0.2	1.2	0.00	0.2	1.3	0.01	0.2	1.3	0.01	0.2	1.4	0.01	0.2	1.5	0.01	0.2	1.6	0.01	0.2	1.7	0.01
Television (100W)	0.6	30.0	0.12	0.6	31.8	0.13	0.7	33.7	0.13	0.7	35.7	0.14	0.8	37.9	0.15	0.8	40.1	0.16	0.9	42.6	0.17
Rice Cookers (500W)	1.9	468.8	1.88	2.0	496.9	1.99	2.1	526.7	2.11	2.2	558.3	2.23	2.4	591.8	2.37	2.5	627.3	2.51	2.7	664.9	2.66
Refrigerators (250W)	0.3	15.6	0.31	0.3	16.6	0.33	0.3	17.6	0.35	0.3	18.6	0.37	0.3	19.7	0.39	0.3	20.9	0.42	0.4	22.2	0.44
Additional Evening Peak		1488	**6.20**		1577	**6.57**		1671	**6.97**		1772	**7.38**		1878	**7.83**		1991	**8.30**		2110	**8.80**
Average day time demand		1567			1684			1810			1946			2092			2249			2418	
Total peak demand		**3054**			**3261**			**3482**			**3718**			**3970**			**4240**			**4528**	
CFL for GLS market penetration rate		10%																			
T10 for T12 market penetration rate		0%																			
EE Rice Cookers penetration rate		10%																			
EE Refrigerator penetration rate		10%																			

Peak Demand: Scenario I	2001			2002			2003			2004			2005			2006			2007		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	27.0	864.0	3.46	28.6	915.8	3.66	27.3	873.7	3.49	25.7	823.2	3.29	23.9	763.5	3.05	21.7	693.7	2.77	19.2	612.8	2.45
Fluorescent tubes (40W)	2.7	108.0	0.43	2.9	114.5	0.46	3.0	121.3	0.49	3.2	128.6	0.51	3.4	136.3	0.55	3.6	144.5	0.58	3.8	153.2	0.61
Thin Tubes (36W)	-	0.0	0.00	-	0.0	0.00	-	0.0	0.00	-	0.0	0.00	-	0.0	0.00	-	0.0	0.00	-	0.0	0.00
CFLs (10W)	0.2	1.2	0.00	0.2	1.3	0.01	3.2	25.6	0.10	6.6	52.9	0.21	10.4	83.3	0.33	14.7	117.2	0.47	19.4	154.9	0.62
Television (100W)	0.6	30.0	0.12	0.6	31.8	0.13	0.7	33.7	0.13	0.7	35.7	0.14	0.8	37.9	0.15	0.8	40.1	0.16	0.9	42.6	0.17
Rice Cookers (500W)	1.9	468.8	1.88	2.0	496.9	1.99	1.9	474.0	1.90	1.8	446.6	1.79	1.7	414.3	1.66	1.5	376.4	1.51	1.3	332.5	1.33
Energy Efficient Rice Cookers (450W)	-	0.0	0.00	-	0.0	0.00	0.2	47.4	0.19	0.4	100.5	0.40	0.7	159.8	0.64	1.0	225.8	0.90	1.3	299.2	1.20
Refrigerators (250W)	0.3	15.6	0.31	0.3	16.6	0.33	0.3	15.8	0.32	0.2	14.9	0.30	0.2	13.8	0.28	0.2	12.5	0.25	0.2	11.1	0.22
Energy Efficient Refrigerators (220W)	-	0.0	0.00	-	0.0	0.00	0.0	1.5	0.03	0.1	3.3	0.07	0.1	5.2	0.10	0.1	7.4	0.15	0.2	9.8	0.20
Additional Evening Peak		1488	**6.20**		1577	**6.57**		1593	**6.65**		1606	**6.71**		1614	**6.76**		1618	**6.79**		1616	**6.80**
Average day time demand		1567			1684			1810			1946			2092			2249			2418	
Total peak demand		**3054**			**3261**			**3404**			**3552**			**3706**			**3867**			**4034**	
CFL for GLS market penetration rate		15%																			
T10 for T12 market penetration rate		20%																			
EE Rice Cookers penetration rate		10%																			
EE Refrigerator penetration rate		10%																			

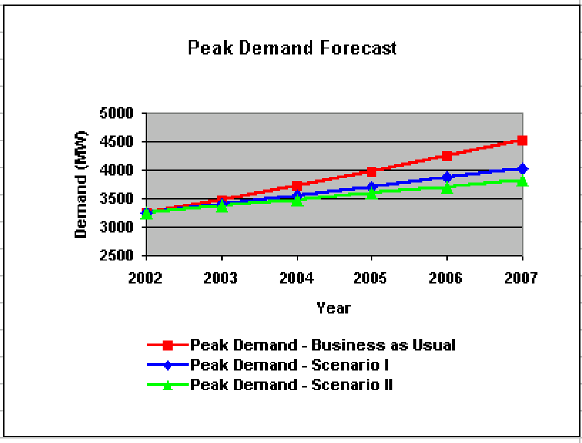
Peak Demand: Scenario II	2001			2002			2003			2004			2005			2006			2007		
Domestic Appliance	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)	Estimation (million units)	Evening Peak Demand (MW)	Daily Energy Consumed (GWh)
GLSs (40W)	27.0	864.0	3.46	28.6	915.8	3.66	25.8	825.2	3.30	22.5	720.3	2.88	18.7	599.9	2.40	14.5	462.5	1.85	9.6	306.4	1.23
Fluorescent tubes (40W)	2.7	108.0	0.43	2.9	114.5	0.46	2.4	97.1	0.39	1.9	77.2	0.31	1.4	54.5	0.22	0.7	28.9	0.12	-	0.0	0.00
Thin Tubes (36W)	-	0.0	0.00	-	0.0	0.00	0.6	27.9	0.11	1.3	59.2	0.24	2.0	94.1	0.38	2.9	133.0	0.53	3.8	176.2	0.70
CFLs (10W)	0.2	1.2	0.00	0.2	1.3	0.01	4.7	37.8	0.15	9.8	78.6	0.31	15.5	124.2	0.50	21.9	175.0	0.70	28.9	231.5	0.93
Television (100W)	0.6	30.0	0.12	0.6	31.8	0.13	0.7	33.7	0.13	0.7	35.7	0.14	0.8	37.9	0.15	0.8	40.1	0.16	0.9	42.6	0.17
Rice Cookers (500W)	1.9	468.8	1.88	2.0	496.9	1.99	1.9	472.4	1.89	1.8	443.3	1.77	1.6	408.9	1.64	1.5	368.8	1.48	1.3	322.5	1.29
Energy Efficient Rice Cookers (450W)	-	0.0	0.00	-	0.0	0.00	0.2	48.8	0.20	0.5	103.5	0.41	0.7	164.6	0.66	1.0	232.6	0.93	1.4	308.2	1.23
Refrigerators (250W)	0.25	15.6	0.31	0.27	16.6	0.33	0.25	15.8	0.32	0.24	14.9	0.30	0.22	13.8	0.28	0.20	12.5	0.25	0.18	11.1	0.22
Energy Efficient Refrigerators (220W)	-	0.0	0.00	-	0.0	0.00	0.03	1.5	0.03	0.06	3.3	0.07	0.09	5.2	0.10	0.13	7.4	0.15	0.18	9.8	0.20
Additional Evening Peak		1488	**6.20**		1577	**6.57**		1560	**6.52**		1536	**6.43**		1503	**6.32**		1461	**6.16**		1408	**5.97**
Average day time demand		1567			1684			1810			1946			2092			2249			2418	
Total peak demand		**3054**			**3261**			**3371**			**3482**			**3595**			**3710**			**3826**	

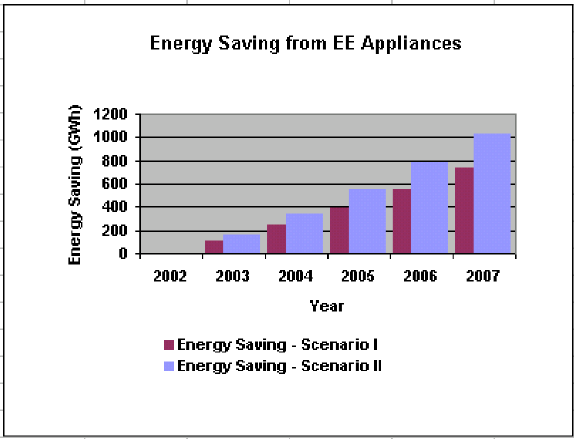
Daily Energy Consumed from Domestic Appliances during Evening Peak Hours - Lighting & Televisions (equation 2)

Daily Energy Consumed from Domestic Appliances (both peak and off-peak hours) - Rice Cookers & Refrigerators (equation 3)

Table B-4: Summary of Peak Demand and Energy Saving

	2002	2003	2004	2005	2006	2007
Installed Capacity	4152	5094	5804	6699	6999	7199
Maximum Demand (actual & BPBD's forecast)	3078	3324	3590	3877	4188	4523
Peak Demand - Business as Usual (MW)	3261	3482	3718	3970	4240	4528
Peak Demand - Scenario I (MW)	3261	3404	3552	3706	3867	4034
Peak Demand - Scenario II (MW)	3261	3371	3482	3595	3710	3826
Peak Demand saving, base case vs. scenario I, (MW)	**0**	**78**	**166**	**264**	**373**	**494**
Peak Demand saving, base case vs. scenario II, (MW)	**0**	**111**	**236**	**375**	**530**	**702**
Energy Demand from Appliances - Business as Usual (GWh)	2399	2543	2695	2857	3029	3210
Energy Demand from Appliances - Scenario I (GWh)	2399	2427	2450	2468	2478	2481
Energy Demand from Appliances - Scenario II (GWh)	2399	2379	2349	2306	2249	2178
Energy saving from EE Appliances - Scenario I, (GWh)	**0**	**116**	**245**	**389**	**550**	**729**
Energy saving from EE Appliances - Scenario II, (GWh)	**0**	**164**	**347**	**551**	**779**	**1033**





Peak Demand Saving within 5 years - Scenario I (MW)	**494**
Peak Demand Saving within 5 years - Scenario II (MW)	**702**
5-Year Cumulative Energy Saving - Scenario I (GWh)	**2030**
5-Year Cumulative Energy Saving - Scenario II (GWh)	**2874**